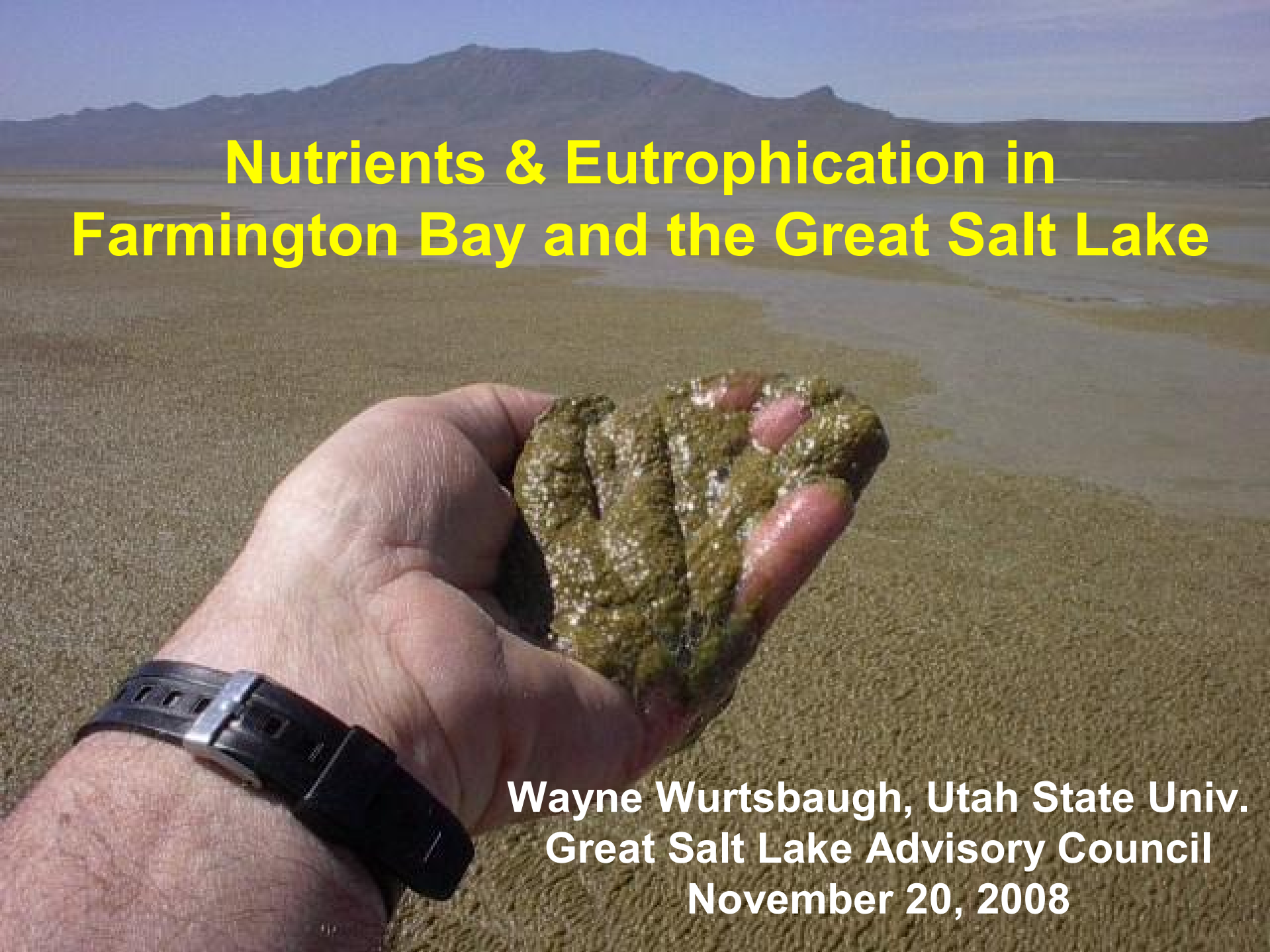


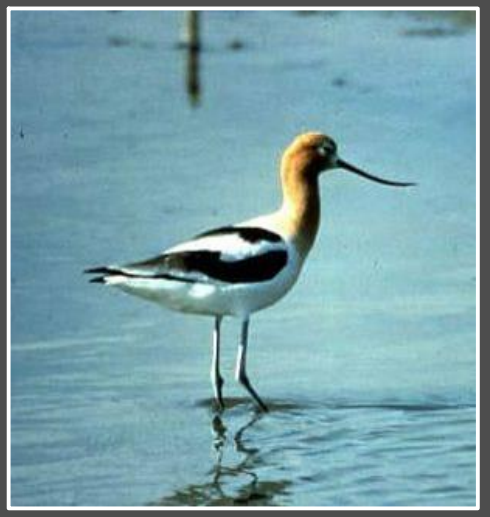
Nutrients & Eutrophication in Farmington Bay and the Great Salt Lake

Wayne Wurtsbaugh, Utah State Univ.

Great Salt Lake Advisory Council

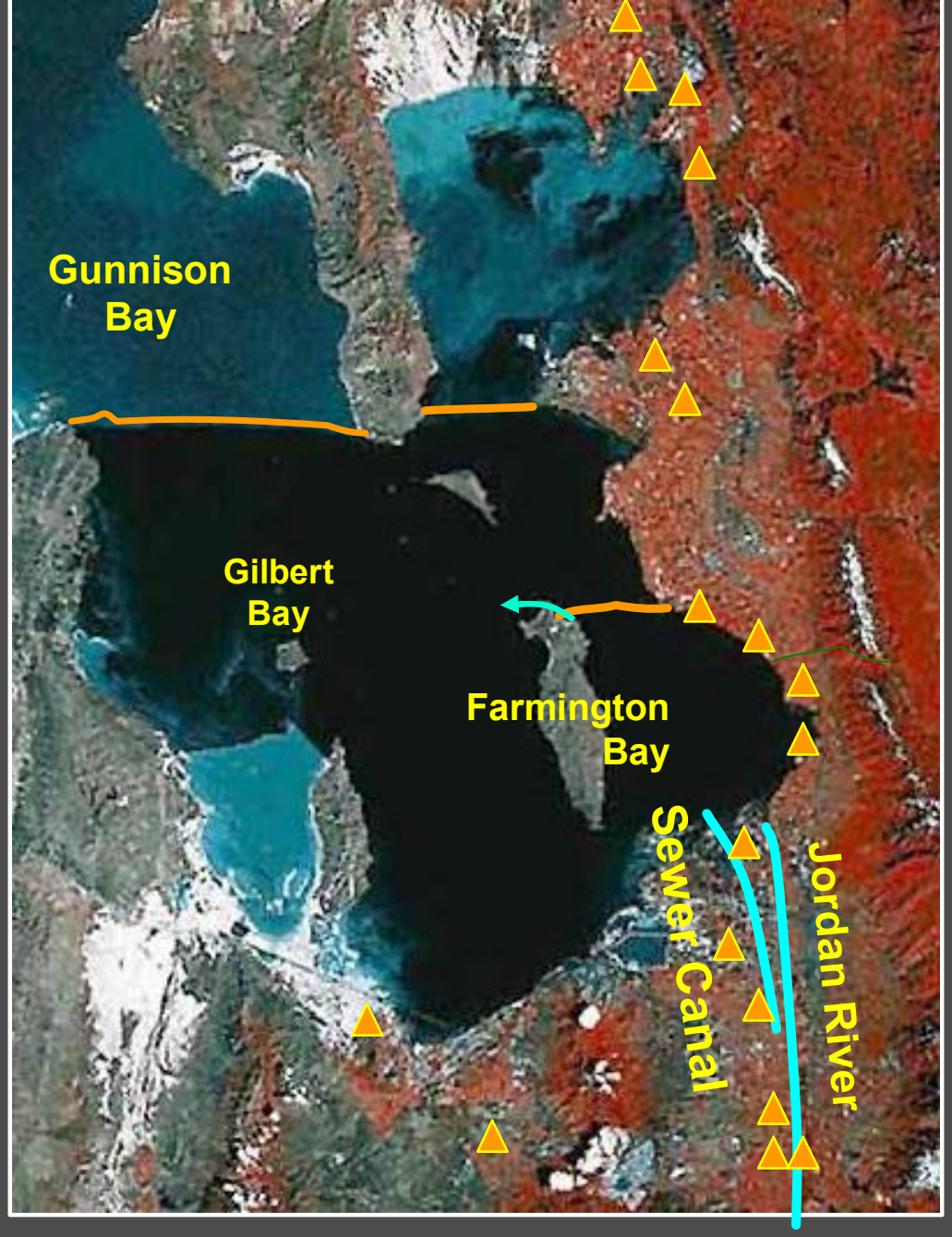
November 20, 2008

Designated *Beneficial Uses* & Issues



- Aquatic Wildlife
  - Brine shrimp
  - Brine flies
  - Other insects
  - Birds
  - Fish (potentially)

- Recreational Use
- Contact recreation
  - Odors (Lake stink)



Hydrology & Pollution

Farmington Bay

- Length: 14 miles
- Area: ca. 56,000 acres
- Average depth: 2-3 ft
- Salinity: 0.2 - 9%

(seawater is 3.5%)

▲ Waste Water Treatment Plants

Secondary Sewage Treatment

Household Organic Wastes + Industrial Wastes + (Storm Wastes)

↘

Treated to Remove Organic Matter & Some Nutrients (P, N)

↘

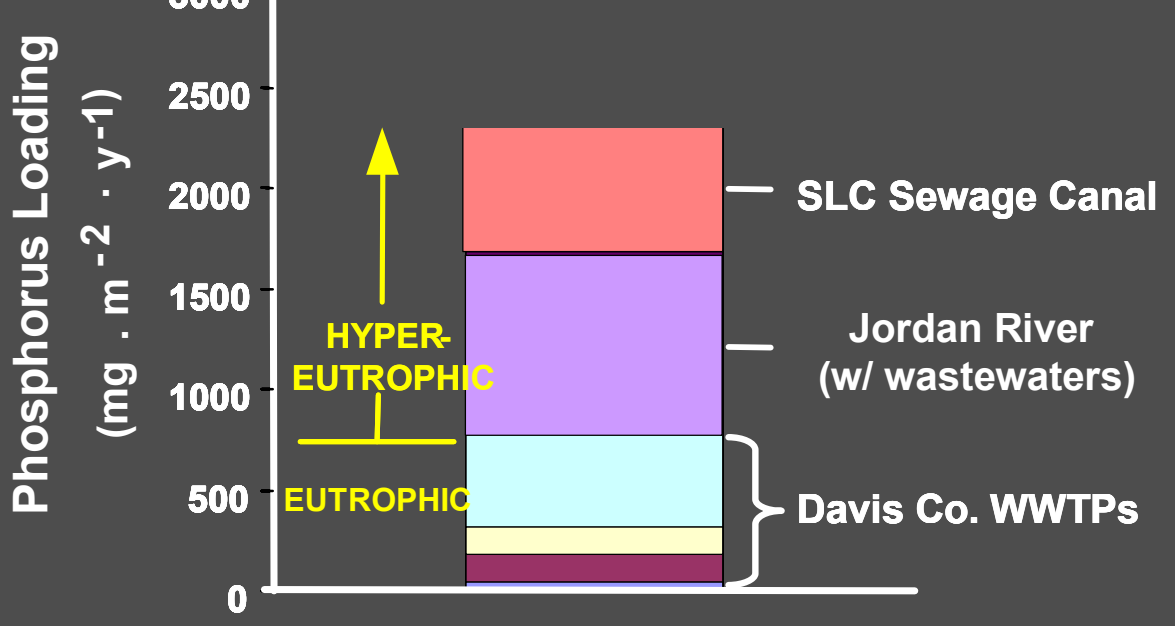
Release high levels of Phosphorus and Nitrogen

(Nutrients–Fertilizer)

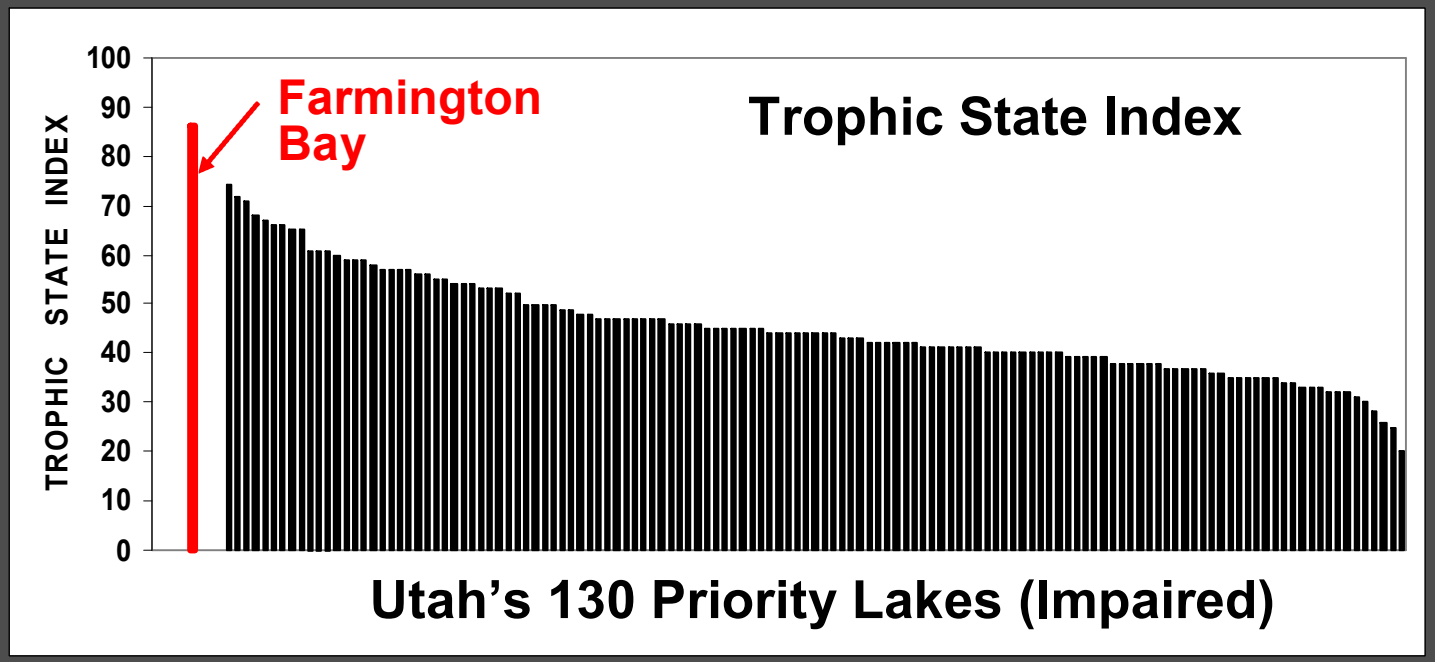
Nutrients Grow Algae!

Excess nutrients and algal growth are referred to as eutrophication

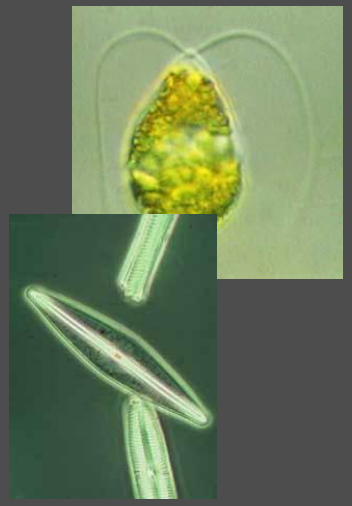
Very High Nutrient Loading and Eutrophication



- Source: D. Gross in Wurtsbaugh et al. 2002
- Based on data of the UDWQ for 1999 & 2000: Storet database

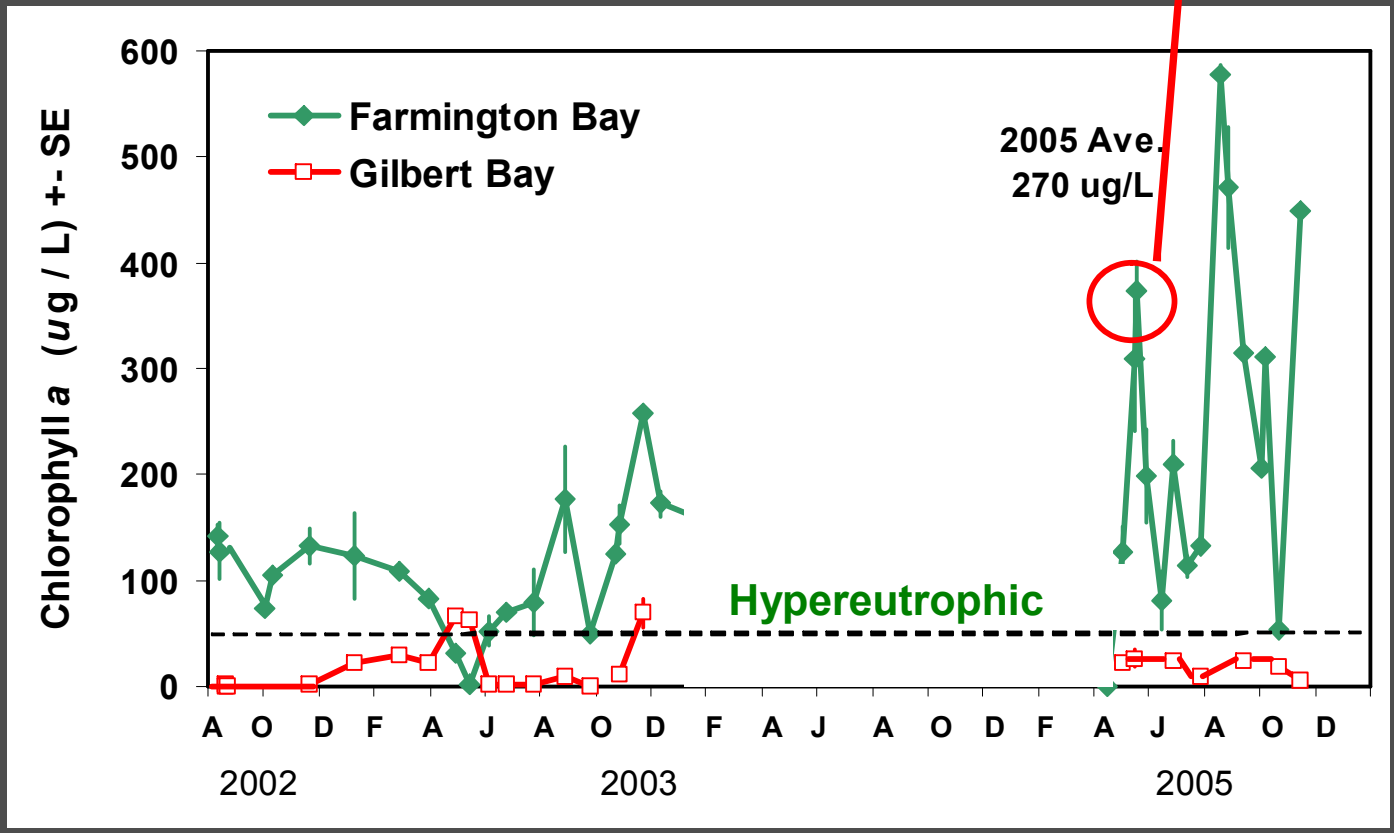


Nutrients and salinity control….



Microscopic Algae

Chlorophyll levels indicate excessive algal blooms in Farmington Bay



Problems:
Toxicity of Cyanobacteria

Algae toxin blamed in teen's death

Associated Press

The Dane County coroner has concluded that a teenager's death last year was from exposure to a toxin released by algae.

Dane Rogers, 17, of Cottage Grove, went into shock and suffered a seizure

Stanley said he decided to release the report to make the public aware of the potential dangers of algal toxins in small ponds.

"There are a lot of ponds out there with a lot more algae than was in this one," he said. "We wanted the public to know that you should not go swim-

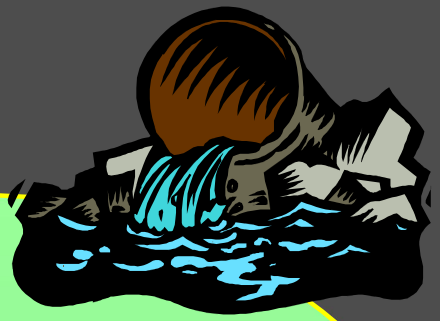
The Capital Times, Madison Sept. 6, 2003

Cyanobacteria can cause severe skin rashes in sensitive individuals

"At least 6000 birds of 47 species, including endangered ones, such as marbled teal and white-head duck, died within two weeks of the algal bloom." *Veterinary Record (2007)*

Cyanobacteria densities reach 10X World Health Organization's recommendation for contact recreation and 20X densities causing bird mortalities elsewhere.

Problems:
Anoxia & Odors



ALGAE ← Nutrients

Death & Decomposition

H_2S (rotten egg smell)

O_2

In a 2002 National Geographic article the lake as a whole was " . . . derided as a putrid, fly-infested sump, a dead thing"

Odor Survey Around Lake

Table 1. Odor survey of residents and visitors to the Great Salt Lake, August-November 2003. Participants were asked to rate the odor level each day on the following scale:

1-None; 2-Mild; 3-Moderate; 4-Strong; 5-Unbearable.

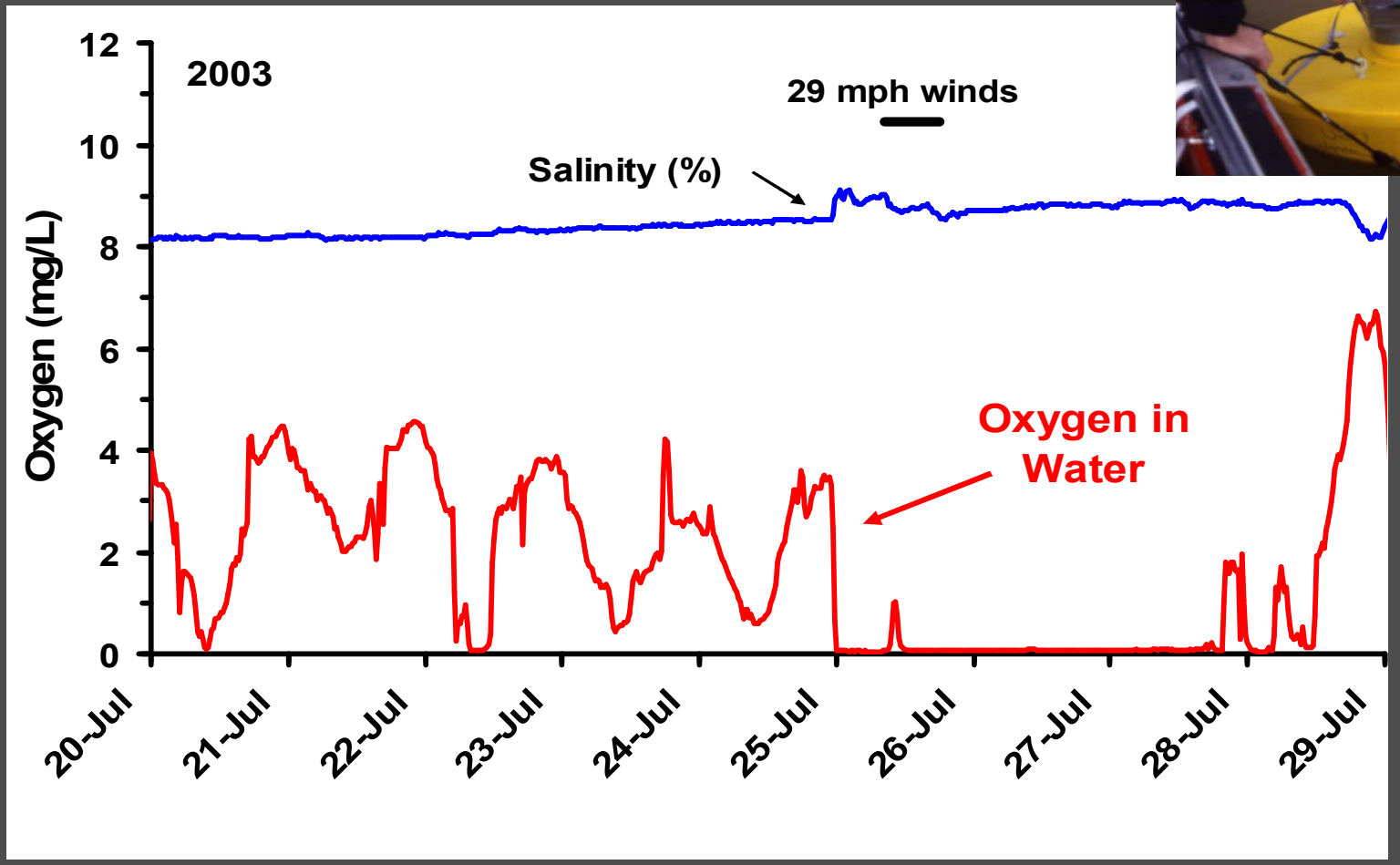
Because daily entries were inconsistent among participants, and because odor is highly subjective, the results here are considered preliminary.

	Odor Rating			
Location	Responses	Average	Min	Max
Farmington/Ogden Bays: Responses of people driving to Antelope Island	109	3.3	1	5
Farmington/Ogden Bay: Gate for Antelope Island State Park	94	1.6	1	5
Antelope Island	12	1.7	1	3
Farmington Bay Refuge	92	1.2	1	3
Great Salt Lake State Park - Saltair	97	1.1	1	4**
Bear River Mig. Bird Refuge	17	1.2	1	3
Promontory Point	84	1.5	1	3

** Wind from east (i.e. Farmington Bay)

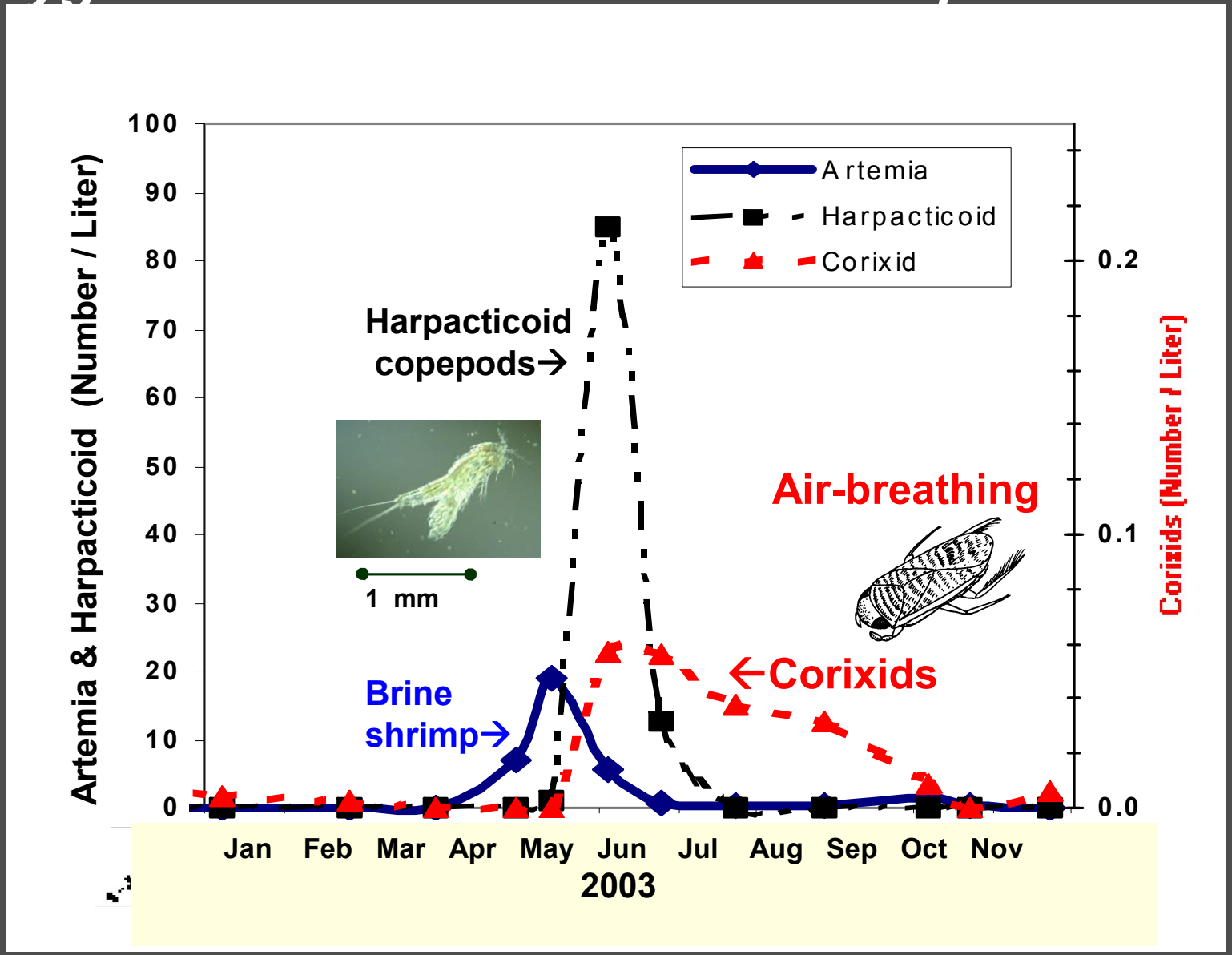
Problems:

- Oxygen loss from water (anoxia)
- Decaying algae strip oxygen from water column
-

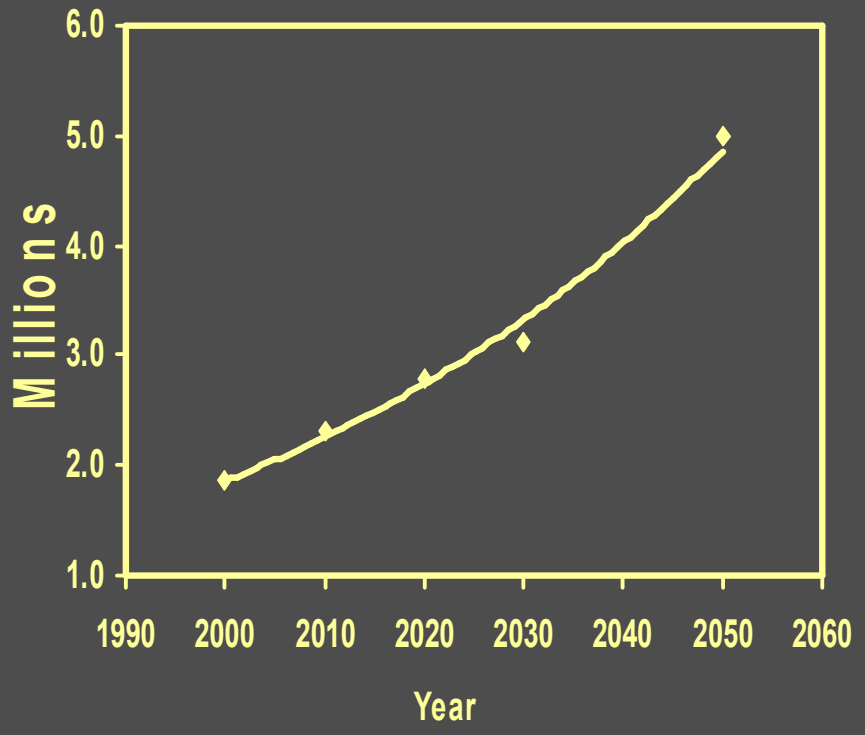


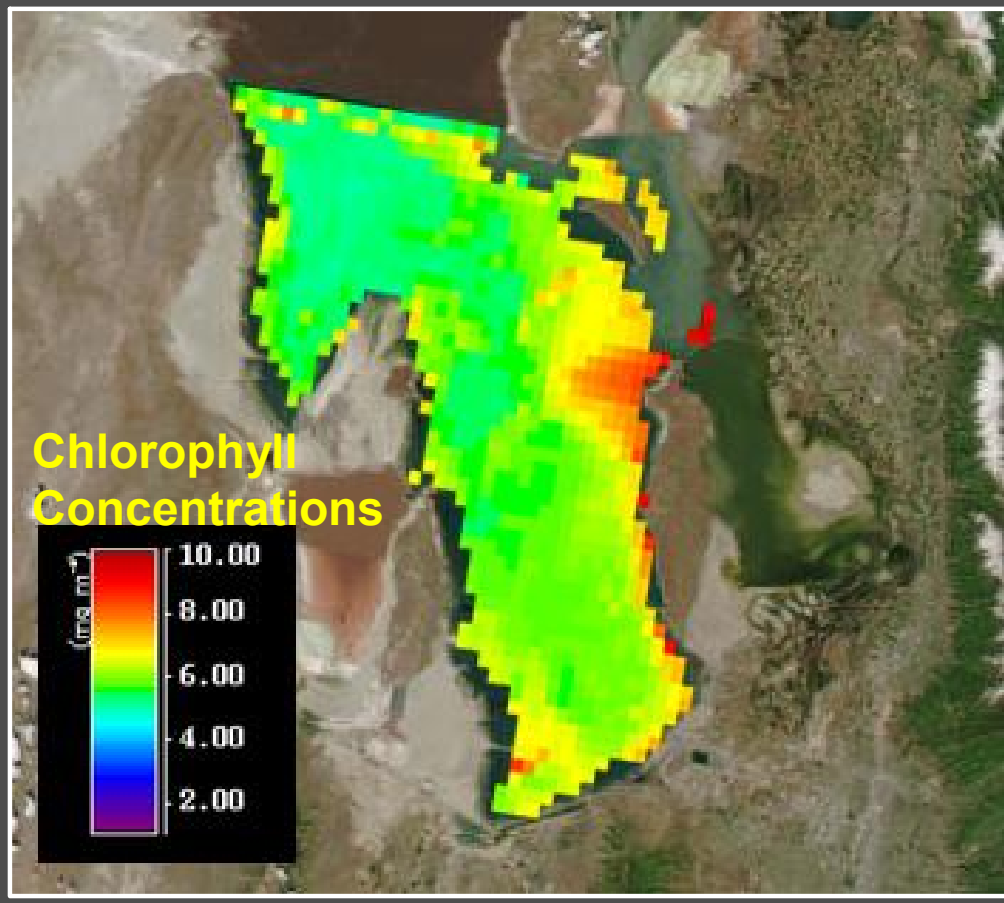
Problems:

- Low oxygen ⟶ Low invertebrates in open waters



Remote Sensing (MODIS Satellite) demonstrates how Farmington Bay Influences Gilbert Bay





- How will a 250% increase in population influence Farmington and Gilbert Bays?

Summary

- Farmington Bay is hypereutrophic due to excessive nutrient input from wastewater treatment plants & non-point sources.
- Toxic cyanobacteria are extremely abundant at salinities < 5%. This presents human health problems and potential problems for birds and mammals.
- Anoxia is common and limits invertebrate abundances in the open waters.
- Odor issues due to eutrophication are difficult to assess but likely reduce recreational use of lake.
- Population increases will exacerbate problem in Farmington Bay and potentially in Gilbert Bay as well.

What can be done?

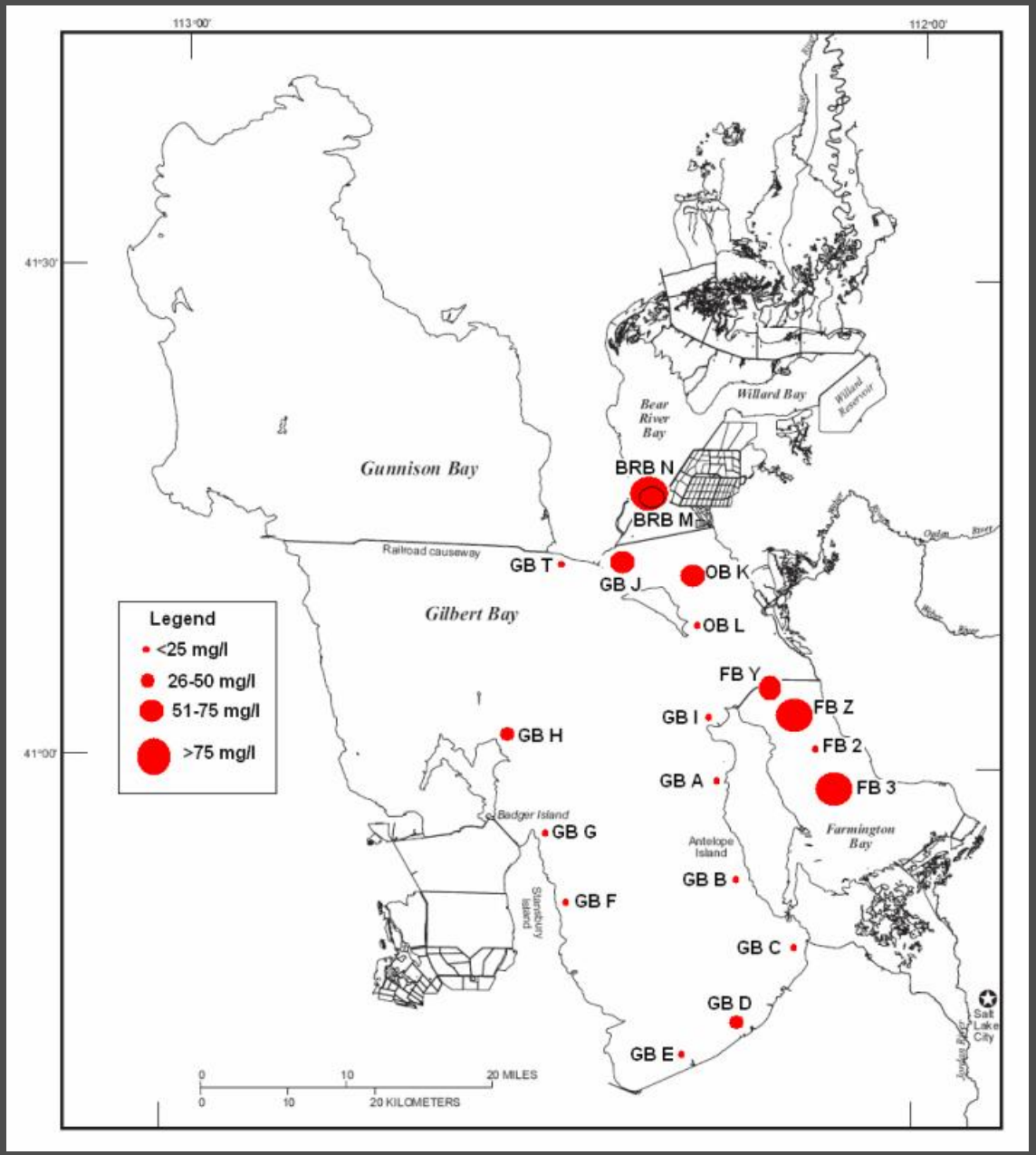
- *Breaching the automobile causeway to increase salinities*
- *Diversion of the Salt Lake City Sewage Canal and the wastewater outfalls from Davis County treatment plants to the larger Gilbert Bay*
- *Flushing Farmington Bay with freshwater from the Jordan River during spring runoff*
- *Tertiary treatment of sewage wastes*

Thanks

- Funding
  - Utah Forestry, Fire and State Lands
  - Utah State University
  - Tides Foundation
  - US Geological Survey
  - Central Davis Sewer Treatment District (Utah Division of Water Quality)

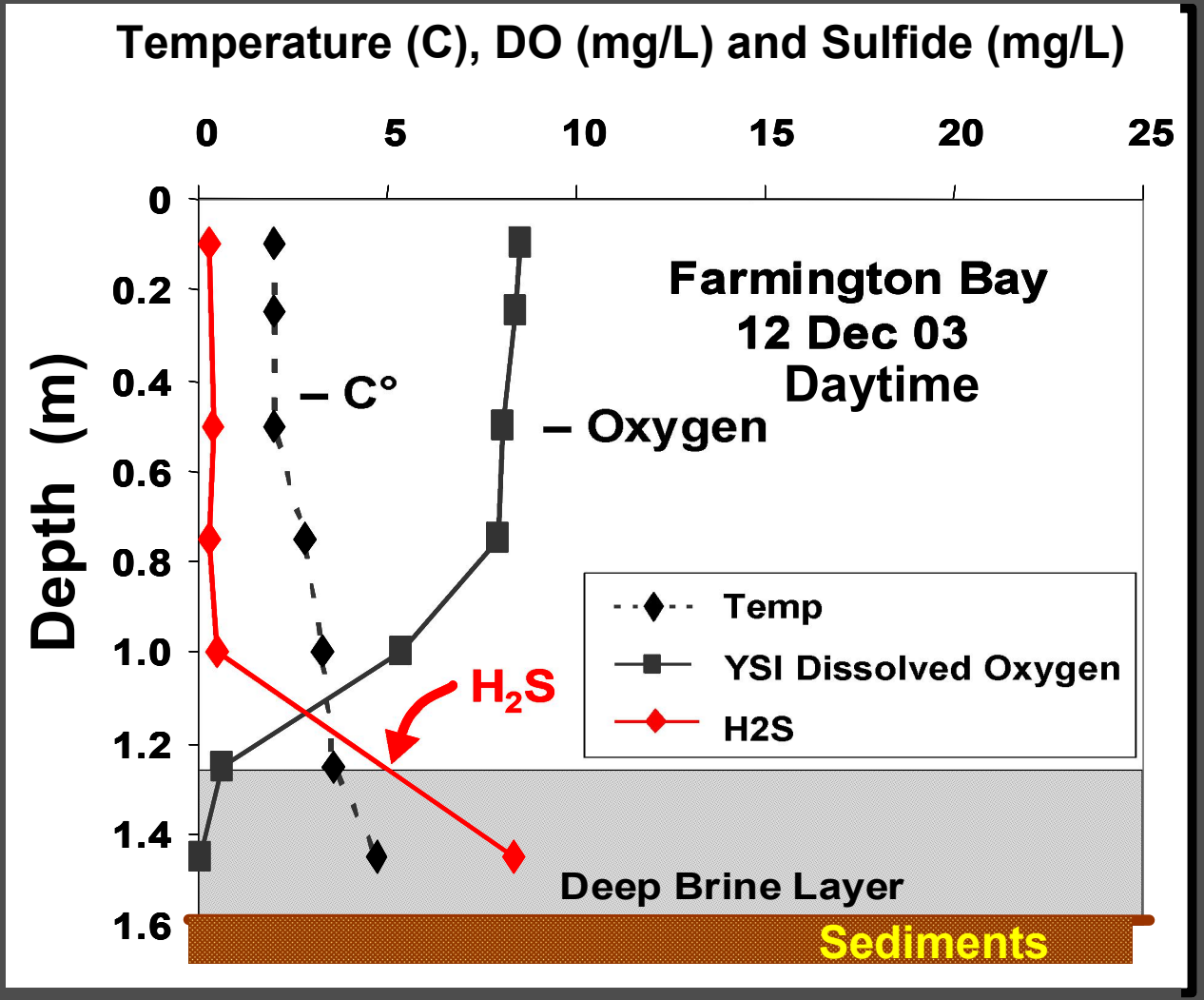
- Assistance
  - David Naftz (USGS)
  - Shane Brandt (U. New Hampshire)
  - Amy Marcarelli (USU)
  - Utah Division of Wildlife Resources Personnel
  - Theron Miller, Utah DWQ
  - Undergraduate Students in WATS 4510

Hydrogen Sulfide Survey of Lake Sediments



Water Quality

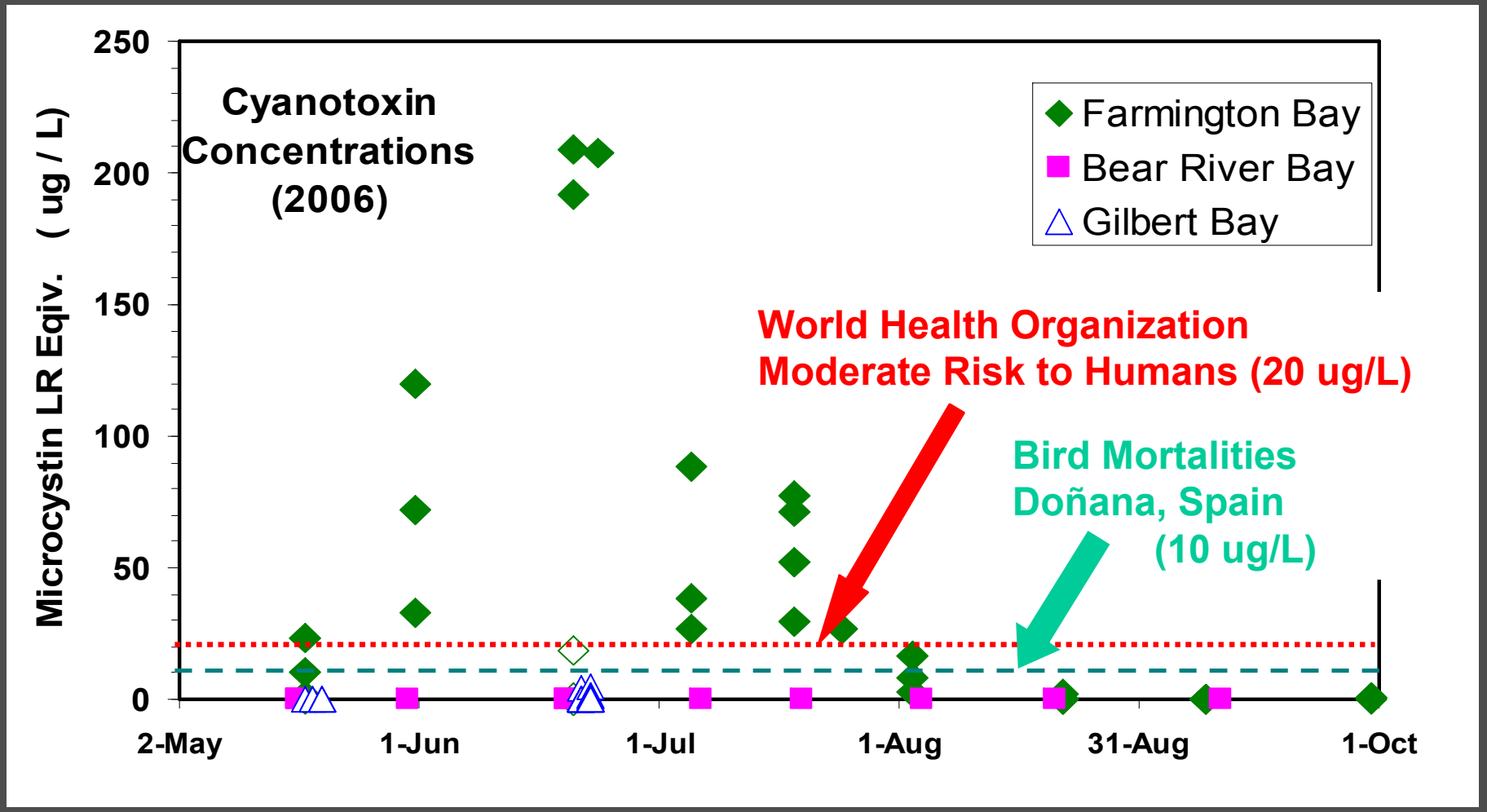
Oxygen and H_2S Conditions



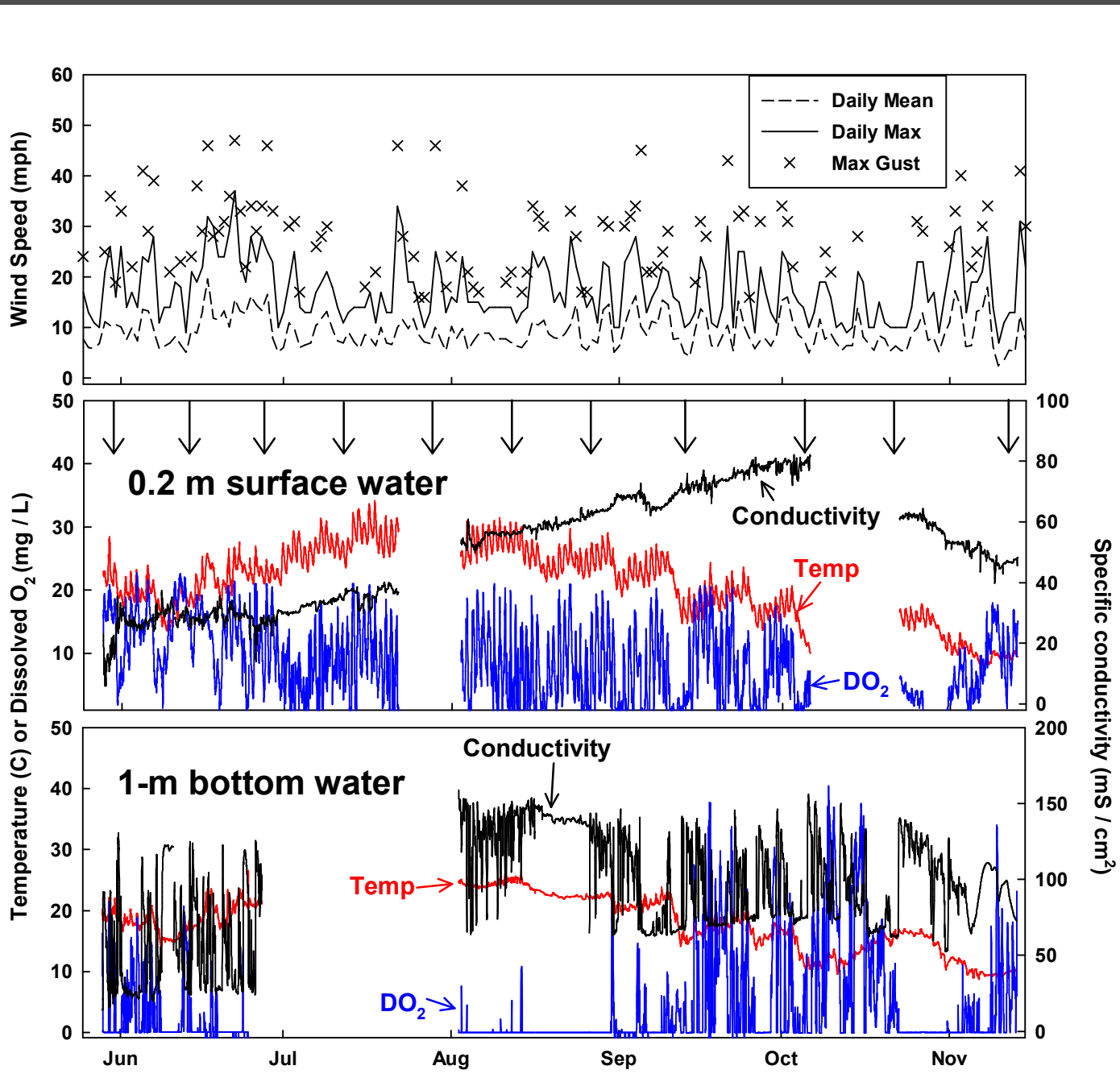
Depth profile of oxygen, temperature and hydrogen sulfide. Grey area represents the deep brine layer.

Dredge samples indicate there is little invertebrate prey in water greater than 1 ft deep

Cyanotoxin Levels in 3 Bays of the Great Salt Lake



Frequent diel & sometimes prolonged anoxia



“Algal Toxins—Initiators of Avian Botulism?”

Murphy et al. (2000). *ENVIRONMENTAL TOXICOLOGY 15*

Is this a cause of botulism outbreaks in Great Salt Lake wetlands?